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(NASA-CR-193495) SEARCHING FOR THE
WHITE DWARF IN DWARF NOVAE. SLOW
RISE SYMMETRICAL OUTBURSTS IN SS
CYGNI (American Association of
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FINAL TECHNICAL REPORT

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Project Titles 1. SEARCHING FOR THE WHITE DWARF IN DWARF NOVAE
 2. SLOW RISE SYMMETRICAL OUTBURSTS IN SS CYGNI

Proposing Organization American Association of Variable Star Observers (AAVSO)

Principal Investigator Janet Akyuz Mattei

Scientific Objectives of the Proposed Projects

1. SEARCHING FOR THE WHITE DWARF IN DWARF NOVAE. The first objective of the project funded by grant NAG5-1460 was to provide information on the brightness of 11 dwarf nova type cataclysmic variables both prior to and during nine 8-hour shift observing runs with the International Ultraviolet Explorer (IUE). This information was essential to observing the stars at their quiescent state in order to search for their white dwarf components. The second objective under this grant was to compile all the optical observations obtained on these targets, digitize and evaluate them, and provide them to the IUE team for correlation with IUE observations.
2. SLOW RISE SYMMETRICAL OUTBURSTS IN SS CYGNI. The first objective of the project funded by NAG5-1460, Supplement 1, 2 was to analyze the optical behavior of the dwarf nova SS Cygni, determine optimum times for the occurrence of its rare symmetrical outbursts (occurring once every two years) for scheduling IUE observations, and provide simultaneous optical monitoring during the IUE observing runs. The second objective was to compile all the optical observations obtained on SS Cygni, evaluate them, and provide them to the IUE team for correlation with the IUE data.

Description of the Projects and the Results

1. SEARCHING FOR THE WHITE DWARF IN DWARF NOVAE. Dwarf nova type cataclysmic variables are close binary systems with a white dwarf primary and a cool secondary in which the cool star is losing mass to an accretion disk around the white dwarf. The eruptions (outbursts) of these systems are caused by brightening of the disk, either due to instabilities in the disk itself or to the rate of mass transfer. Light from the white dwarf itself is not seen in the visual because it is overwhelmed by light from the cool star and the accretion disk. The only possibility for direct detection of the white dwarf primary is to look in the far ultraviolet during the quiescent state of the system. To achieve this, 11 dwarf novae of varying outburst periods were selected as observing targets for the nine shifts granted with the IUE. The shifts were blocked in three groups of three in fall 1989, June 1990, and fall 1990. Shifts within each group were separated by intervals of 7 to 10 days.

It was essential that the targets be observed at their quiescent state. Therefore, prior to each observing run 500 AAVSO observers worldwide were alerted, via AAVSO Alert Notices, to observe very closely the observing targets and telephone their observations to AAVSO Headquarters. The Principal Investigator and her technical staff then combined these recent observations with those earlier from the AAVSO International database, do a statistical study on the behavior of each of the observing targets, predict which ones would be at quiescence during the scheduled IUE observing time, and inform Drs. Albert Holm, Howard Lanning, and Edward Nelan of the Space Telescope Science Institute, to whom

the IUE time was granted.

Throughout the IUE observing run, AAVSO observers continued to monitor the targets and notified the Principal Investigator, who in turn informed Dr. Holm. This simultaneous monitoring was essential in case any of the observing targets went into outburst just before or during the IUE observing. Without the AAVSO information on the state of these stars the IUE team could have used hit-and-miss tactics several times before the stars were caught in a quiescent state. Thus the AAVSO information was vital to the most efficient use of the satellite.

Good IUE observations were obtained on six of the observing targets (RX And, Z Cam, SS Cyg, EX Hya, TZ Per, SU UMa) while they were in quiescence. Observations were attempted on two of the targets (RU Peg, V426 Oph), but these attempts failed due to the technical limitations of the IUE.

The AAVSO data on the stars observed with the IUE were compiled and digitized and sent to Dr. Holm for multiwavelength correlation of the observations. The analysis of these data provided new spectroscopic evidence for a white dwarf star found in two of the six observed systems, RX And and TZ Per. In addition, the spectra of SS Cyg were found to be consistent with those reported earlier (A. V. Holm, 1988, in *Decade of UV Astronomy with IUE*, ESA SP 281, 1, 179).

The study of the IUE data is being continued by Drs. Holm, Lanning, and Nelan. They are working to model and to subtract the geocoronal component of the Lyman alpha line in the spectra. When the reduction of the data is completed and accurate temperatures of the white dwarf are derived, the visual magnitude of the white dwarf, the mass ratio of the two stars, and possibly new estimated distances may be predicted.

2. SLOW RISE SYMMETRICAL OUTBURSTS IN SS CYGNI. The dwarf nova SS Cygni is unique in that it has two distinct types of outbursts, the frequent asymmetrical and the infrequent (occurring once about every two years) symmetrical outbursts. It is believed that the evolution of symmetrical outbursts is radically different than that of asymmetrical outbursts. Until this project, while there were 150 IUE images of SS Cygni during its asymmetrical outbursts, there were only two of the symmetrical ones, and these two looked significantly different in regard to the strength of the UV excess flux and the UV emission. Thus, in order to explore the origin of these rare outbursts, observations were scheduled with the IUE as a target of opportunity program which would be carried out as soon as the AAVSO observers reported that an outburst was an symmetrical one.

In order to identify the pattern in the recurrence cycle of the symmetrical outbursts, the longterm AAVSO light curves of SS Cygni were statistically analyzed. The results of this study were used to predict the times of occurrence of these outbursts. Over 500 AAVSO observers worldwide were alerted via AAVSO Alert Notices to monitor SS Cygni closely, particularly during the predicted times, and to phone in their observations during the course of each of the outbursts. Once a symmetrical outburst was identified from the incoming observations by the Principal Investigator (about 24 hours after the outburst began), Dr. Ronald Polidan at NASA Goddard Flight Center, to whom the IUE time has been granted, was alerted so that the IUE observations could be scheduled. Of the 15 outbursts within the two years of the project, the one in May 1990 was identified as a symmetrical outburst and IUE observations were obtained successfully.

Later the AAVSO observations of this outbursts were compiled, digitized, evaluated, and sent to Dr. Polidan for correlating the UV data. This information was used in order to understand the evolution of the symmetrical outbursts, and to be able to distinguish

between the mass overflow model and disk instability using symmetrical outbursts.

The analysis of the multiwavelength data is continuing.

We very much appreciate these awards and acknowledge them with gratitude.

Publications

Holm, A. V., Lanning, H., Mattei, J. A., Nelan, E. 1991, "Searching For the White Dwarf in Dwarf Novae", *Journ. American Assoc. Variable Star Observers*, 20, 166.

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Respectfully submitted

Mar 16, 1993
Date

Janet A. Mattei
Dr. Janet A. Mattei
Principal Investigator